Chapter 620 Geometric Plan Elements

620.01 General

This chapter provides guidance on the design of horizontal alignment, frontage roads, number of lanes, the arrangement of the lanes, and pavement transitions. See the following chapters for additional information:

Chapter	Subject
430	All roadway width requirements for modified design level
440	Lane and shoulder width requirements for full design level
440	Shoulder width requirements at curbs
641	Open highway and ramp lane widths on turning roadways for full design level
642	Superelevation rate and transitions
650	Sight distance
910	Requirements for islands
940	Ramp lane and shoulder requirements

620.02 References

Washington Administrative Code (WAC) 468-18-040, "Design standards for rearranged county roads, frontage roads, access roads, intersections, ramps and crossings"

Utilities Manual M 22-87, WSDOT

Plans Preparation Manual M 22-31, WSDOT

Manual on Uniform Traffic Control Devices for Streets and Highways, USDOT, FHWA; including the *Washington State Modifications to the MUTCD*, WSDOT (MUTCD) http://www.wsdot.wa.gov/biz/trafficoperations/mutcd.htm

Right of Way Manual M 26-01, WSDOT

Local Agency Guidelines (LAG), M 36-63, WSDOT

A Policy on Geometric Design of Highways and Streets (Green Book), 2001, AASHTO

620.03 Definitions

auxiliary lane The portion of the roadway adjoining the traveled way for parking, speed change, turning, storage for turning, weaving, truck climbing, passing, and other purposes supplementary to through-traffic movement.

basic number of lanes The minimum number of general purpose lanes designated and maintained over a significant length of highway.

frontage road An auxiliary road that is a local road or street located on the side of a highway for service to abutting property and adjacent areas and for control of access.

outer separation The area between the outside edge of traveled way for through traffic and the nearest edge of traveled way of a frontage road or collector/distributor road.

turning roadway A curve on an open highway, a curve on a ramp, or a connecting roadway between two intersecting legs of an intersection.

620.04 Horizontal Alignment

(1) General

Horizontal and vertical alignments (Chapter 630) are the primary controlling elements for highway design. It is important to coordinate these two elements with design speed, drainage, intersection design, and aesthetic principles in the early stages of design.

Figures 620-2a through 2c show desirable and undesirable alignment examples for use with the following considerations:

(a) Make the highway alignment as direct as practical and still blend with the topography while considering developed and undeveloped properties, community boundaries, and environmental concerns.

(b) Make highway alignment consistent by:

- Using gentle curves at the end of long tangents.
- Using a transition area of moderate curvature between the large radius curves of rural areas and the small radius curves of populated areas.
- Making horizontal curves visible to approaching traffic.

(c) Avoid minimum radii and short curves unless:

- Restrictive conditions are present and are not readily or economically avoidable.
- On two-lane highways, minimum radii will result in tangent sections long enough for needed passing.

(d) Avoid any abrupt change in alignment. Design reverse curves with an intervening tangent long enough for complete superelevation transition for both curves. See Chapter 642 for more information on superelevation transitions.

(e) Avoid the use of curves in the same direction connected by short tangents (broken back curves); substitute a single larger curve.

(f) Avoid compound curves on open highway alignment if a simple curve can be obtained. When compound curves are used, make the shorter radius at least two-thirds the longer radius. Make the total arc length of a compound curve not less than 500 ft.

(g) On divided multilane highways, take advantage of independent alignment to produce a flowing alignment along natural terrain.

(h) The preferred locations for bridges, interchanges, intersections, and temporary connections are on tangent sections in clear view of drivers.

(i) On two-lane, two-way highways, strive for as much passing sight distance as possible. (See Chapter 650.)

(2) Horizontal Curve Radii

Design speed is the governing element of horizontal curves. For guidance regarding design speed selection see Chapter 440 for full design level, Chapter 430 for modified design level, and Chapter 940 for ramps.

Use the following factors to determine the radius for a curve:

- Stopping sight distance where sight obstructions are on the inside of a curve. Median barriers, bridges, walls, cut slopes, wooded areas, buildings, and guardrails are examples of sight obstructions. See Chapter 650 to check for adequate stopping sight distance for the selected design speed.
- Superelevation is the rotation or banking of the roadway cross section to overcome part of the centrifugal force that acts on a vehicle traversing a curve. Design information on the relationship between design speed, radius of curve, and superelevation is in Chapter 642.
- Coordinate vertical and horizontal alignment. (see Chapter 630.)

Spiral curves, although no longer used on new highway construction or major realignment, still exist on Washington highways. Spirals were used to transition between tangents and circular curves with the horizontal curvature rate increasing from tangent to the central curve and decreasing from curve to tangent. Spirals do not pose an operational concern and may remain in place. See the "Green Book" for information on spirals.

(3) Horizontal Curve Length

A curve is not required for small deflection angles. Figure 620-1 gives the maximum allowable angle without a curve. See Chapter 910 for guidance on angle points or short radii curves in the vicinity of intersections at grade.

Design Speed (mph)	Maximum Angle Without Curve
25	2º17’
30	1º55’
35	1º38’
40	1º26’
45	1º16’
50	1º09’
55	1º03’
60	0º57’
65	0º53’
70	0º49’
75	0º46’
80	0º43’

Maximum Angle Without Curve
Figure 620-1

To avoid the appearance of a kink in the road, the desirable length of curve for deflection angles larger than given in Figure 620-1 is at least 500 ft long.

620.05 Distribution Facilities

(1) General

In addition to the main highway under consideration, other facilities can be provided to distribute traffic to and from the highway and to fulfill access requirements. Highway flexibility can be augmented by:

- Frontage roads
- Collector distributor roads
- On and off connections
- Parallel arterial routes with connections between them and the main highway
- Loop highways around large metropolitan areas

A city or county may be asked to accept a proposed distribution facility as a city street or county road. Plan and design these facilities according to the applicable design values as city streets or county roads. (See Chapter 440.)

(2) Frontage Roads

Frontage roads constructed as part of highway development may serve any of the following purposes:

- To reestablish continuity of an existing road severed by the highway.
- To provide service connections to adjacent property that would otherwise be isolated as a result of construction of the highway.
- To control access to the highway.
- To maintain circulation of traffic on each side of the highway.
- To segregate local traffic from the higher speed through traffic and intercept driveways of residences and commercial establishments along the highway.
- To relieve congestion on the arterial highway during periods of high use or in emergency situations.

Frontage roads are generally not permanent state facilities. They are usually turned back to the local jurisdiction. Plan and design frontage roads as city streets or county roads. (See Chapter 440.) Initiate coordination with the local agency that will be the recipient of the facility early in the planning process, and carry through design and construction. See Chapter 1430 for additional guidance on frontage roads and turnbacks.

Outer separations function as buffers between the through traffic on the highway and the local traffic on the frontage road. The width is governed by requirements for grading, signing, barriers, aesthetics, headlight glare, and ramps. Where possible, make the separation wide enough to allow for development on both sides of the frontage road. Wider separations also move the intersection with the frontage road and a cross road farther from the intersection with the through roadway. It also can reduce the amount of limited access control rights to be acquired. (See Chapter 1430.)

Where two-way frontage roads are provided, a driver on the highway must contend with approaching traffic on the right (opposing frontage road traffic) as well as opposing traffic on the left. Make the outer separation wide enough to minimize the effects of approaching traffic, particularly the headlight glare. See Chapter 700 for information on headlight glare considerations. With one-way same-direction frontage roads, the outer separation need not be as wide as with two-way frontage roads.

Wide separations lend themselves to landscape treatment and can enhance the appearance of both the highway and the adjoining property.

A substantial width of outer separation is particularly advantageous at intersections with cross streets. The wider separation reduces conflicts with pedestrians and bicycles.

Where ramp connections are provided between the through roadway and the frontage road, the minimum outer separation width will depend on design requirements for the ramp termini.

620.06 Number of Lanes and Arrangement

(1) General

The basic number of lanes is designated and maintained over a length of highway. The total number of lanes is the basic number of lanes plus any auxiliary lanes required to meet:

- Level of service (volume-capacity).
- Lane balance.
- Flexibility of operation.

(2) Basic Number of Lanes

Keep the basic number of lanes constant over a highway route, or a significant portion thereof, regardless of changes in traffic volume. See Chapter 440 for the minimum number of lanes for each functional class of highway.

Change the basic number of lanes only for general changes in traffic volume over a substantial length of the route. The recommended location for a reduction in the basic number of lanes is on a tangent section between interchanges or intersections.

To accommodate high traffic volumes for short distances, such as between adjacent interchanges, use auxiliary lanes. When consecutive sections between interchanges require auxiliary lanes, consider increasing the basic number of lanes through the entire length.

(3) Auxiliary Lanes

Auxiliary lanes are added to the basic number of lanes to allow additional traffic movements on short segments. These added lanes are based primarily on volume-to-capacity relationships (Chapter 610).

To ensure efficient operation of auxiliary lanes see the following:

910	Left and right turn lanes and storage for turning
940	Weaving and auxiliary lanes associated with interchanges
1010	Truck climbing and passing lanes

620.07 Pavement Transitions

(1) Lane Transitions

(a) **For lane width changes** that create an angle point in an adjacent lane, the maximum angle is given in Figure 620-1. When a lane width change does not create an angle point in an adjacent lane, a 25:1 taper is sufficient.

(b) To **reduce the number of lanes**, a transition is required. The following guidelines apply:

- Locate transitions where decision sight distance exists, preferably on a tangent section and on the approach side of any crest vertical curve (except the end of climbing lanes which are transitioned in accordance with Chapter 1010).
- Supplement the transition with traffic control devices.
- Reduce the number of lanes by dropping only one at a time from the right side in the direction of travel. (When dropping a lane on the left side, an approved deviation is required.) See the MUTCD when more than one lane in a single direction must be dropped.

- Use the following formula to determine the minimum length of the lane transition for high speed conditions (45 mph or more):

  $L = VT$

  Where:

  L = length of transition (ft)
  V = design speed (mph)
  T = tangential offset width (ft)

- Use the following formula to determine the minimum length of the lane transition for low speed conditions (less than 45 mph):

  $$L = \frac{TV^2}{60}$$

  Where:

  L = length of transition (ft)
  V = design speed (mph)
  T = tangential offset width (ft)

(c) **To increase the number of lanes**, a tangential rate of change in the range of 1:4 to 1:15 is sufficient. Aesthetics are the main consideration.

(d) **For turning roadway** widening width transitions, see Chapter 641.

(2) Median Width Transitions

Whenever two abutting sections have different median widths, use long, smooth transitions (L = VT or flatter). When horizontal curves are present, this can be accomplished by providing the transition throughout the length of the curve. When required on a tangent section, the transition may be applied about the center line or on either side of the median based on whether or not the abutting existing section is programmed for the wider median in the future. To satisfy aesthetic requirements, make the transition length as long as feasible.

620.08 Procedures

When the project will realign the roadway, develop horizontal alignment plans for inclusion in the PS&E. Show the following as needed to maintain clarity and provide necessary information:

- Horizontal alignment details (tangent bearing, curve radius, and superelevation rate)
- Stationing
- Number of lanes
- Intersections, road approaches, railroad crossings, and interchanges (Chapters 910, 920, 930, and 940)
- Existing roadways and features affecting or affected by the project

See the *Plans Preparation Manual* for additional plan requirements.

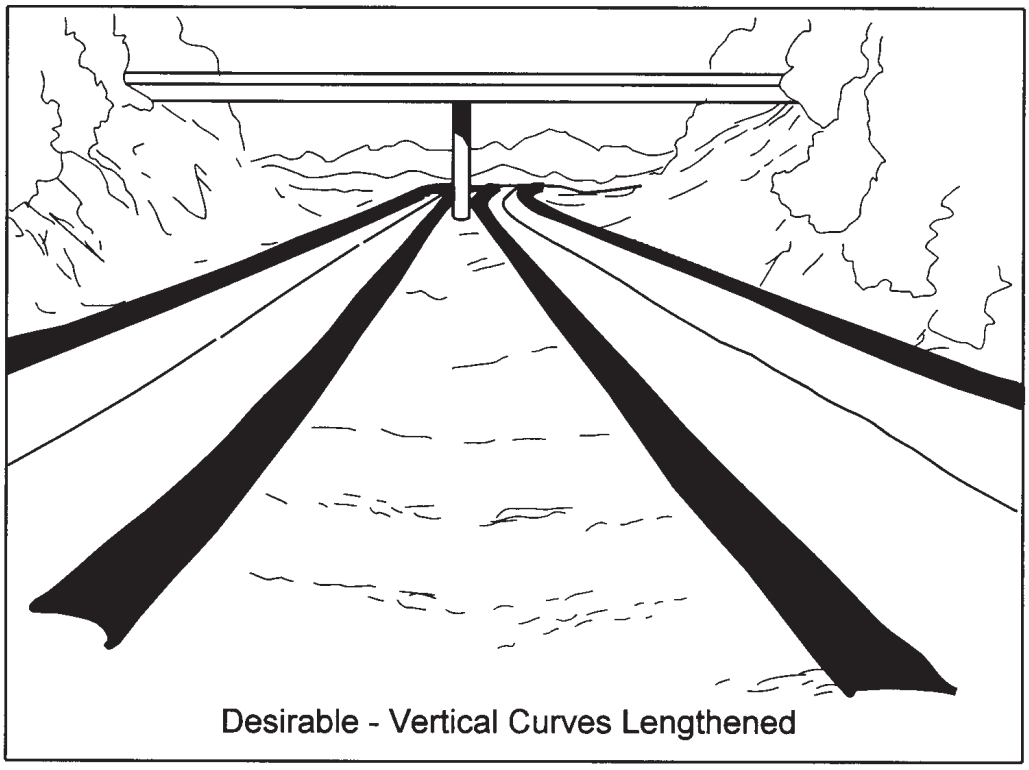
Justify any realignment of the roadway. Include the reasons for the realignment, profile considerations, alternatives considered, and the reasons the selected alignment was chosen.

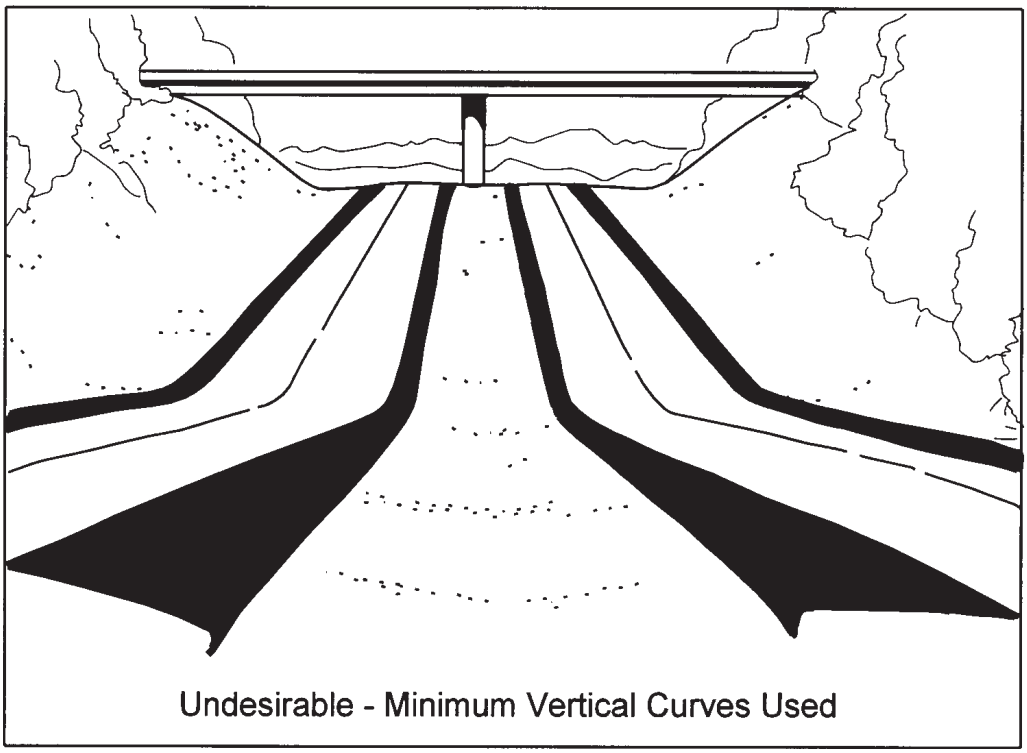
When the project will change the number of lanes, include a capacity analysis supporting the number selected (Chapter 610) with the justification for the number of lanes.

Include with the justification for a frontage road any traffic analyses performed, the social, environmental, and economic considerations, the options considered, and the reasons for the final decision.

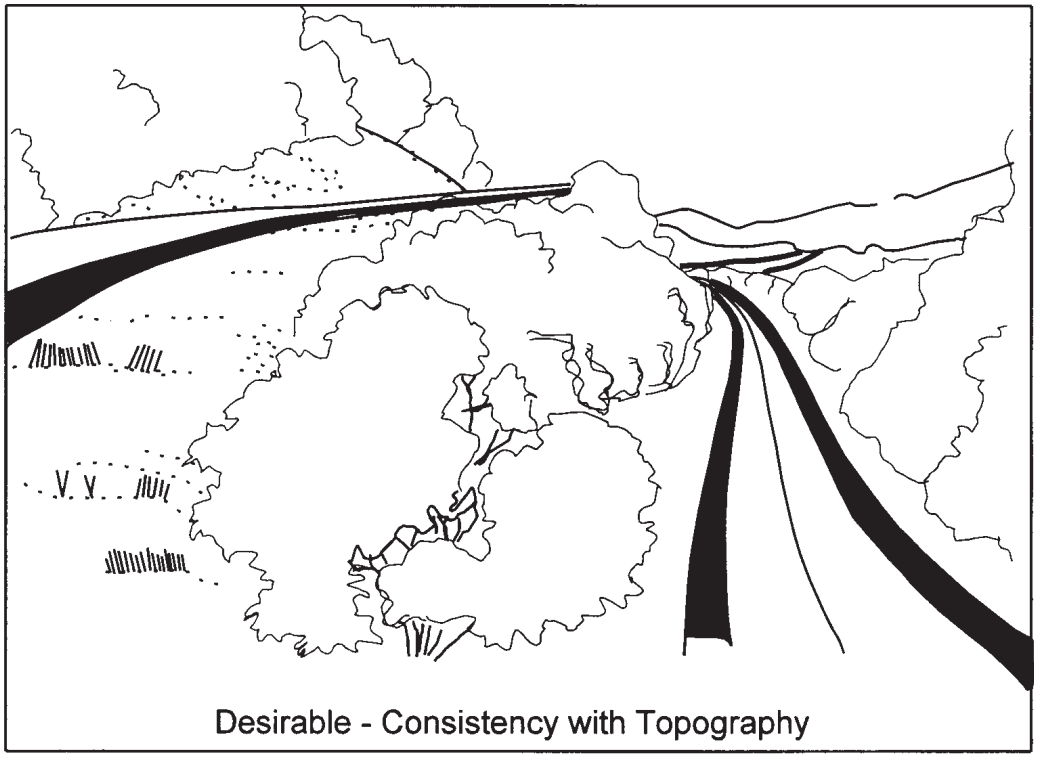
620.09 Documentation

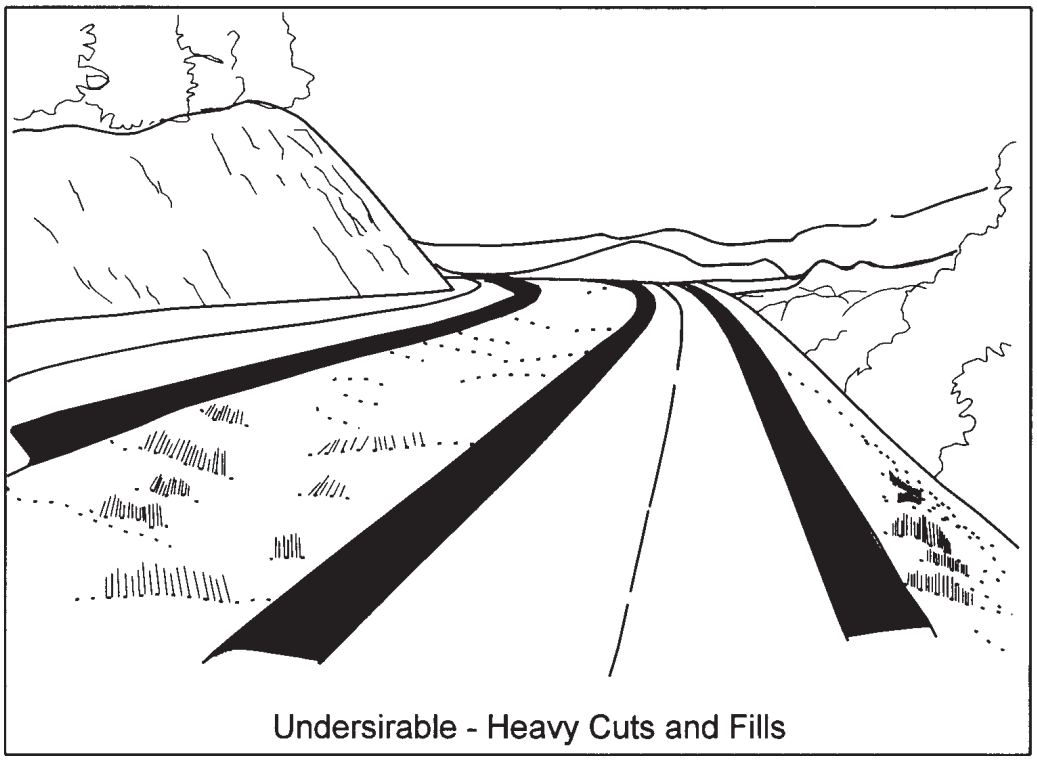
A list of the documents that are to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following web site: http://www.wsdot.wa.gov/eesc/design/projectdev/



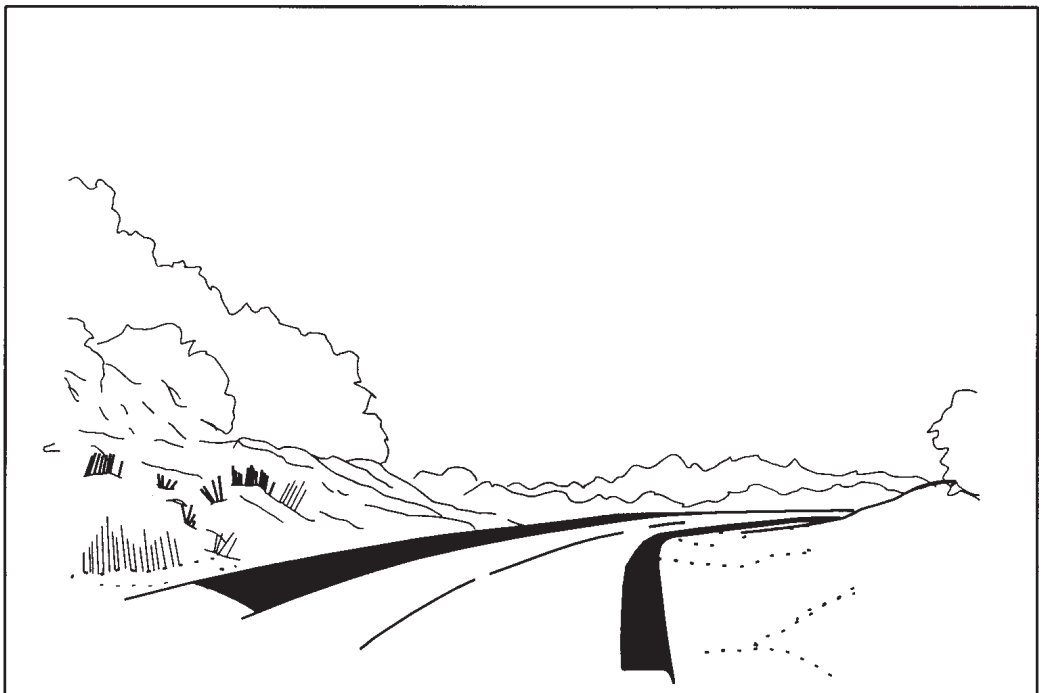


Alignment Examples
Figure 620-2a

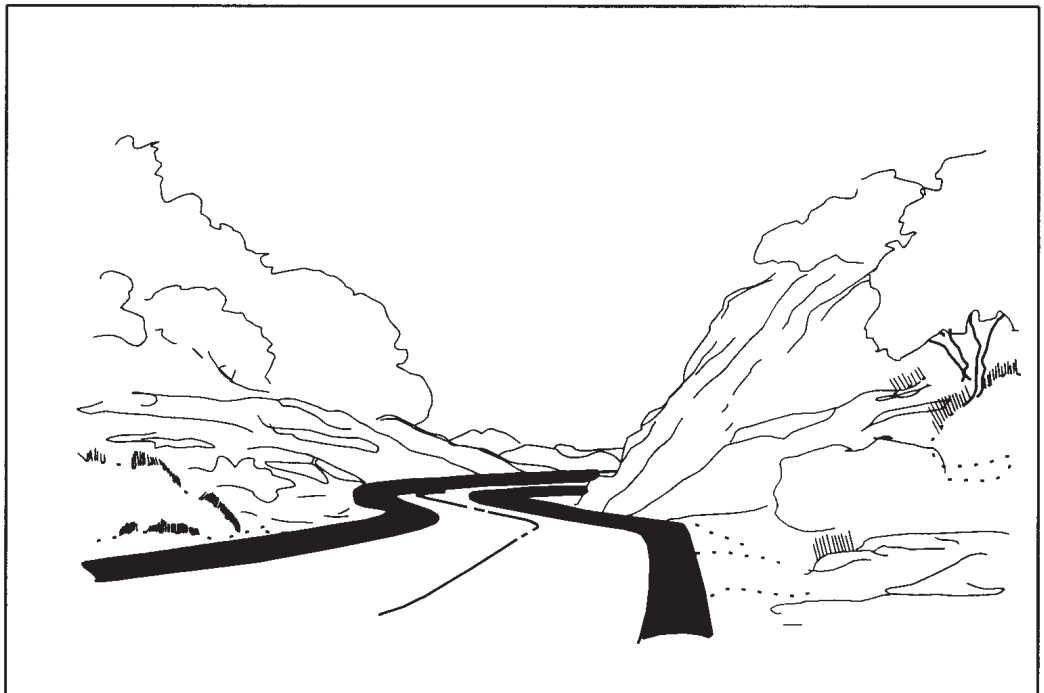




Alignment Examples
Figure 620-2b



Desirable - Daylighting and a Simple Curve



Undesirable - Short Curve Reversals

Alignment Examples
Figure 620-2c